

### REMARKS

The specification has been amended to correct minor errors. A marked up version of the amended paragraphs of the specification is attached hereto pursuant to 37 C.F.R. § 1.121(b)(iii). Claim 1 has been amended for clarity. A marked up version of the amended claim is also attached hereto pursuant to 37 C.F.R. § 1.121(c)(ii). New claims 17-20 have been added. Claims 2-16 remain unchanged. Thus, claims 1-20 are presently pending in this application for consideration.

The amendments to the present application are made to place the application in better form and to place the application in condition for allowance. No new matter has been added. Entry and consideration of these amendments prior to the first Office Action are respectfully requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at Los Angeles, telephone number (213) 337-6742 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

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Version with markings to show changes made:

IN THE SPECIFICATION:

Please amend the paragraphs starting on page 5, line 12 through page 6, line 25 as follows:

The invention has been developed taking the problems into consideration, and an [objective] advantage thereof is to provide a voltage supplying device that can promptly and precisely provide a required charging voltage without an offset canceling circuit, and a semiconductor device, an electro-optical device and an electronic instrument using the same.

According to one aspect of the present invention, there is provided a voltage supplying device [which supplies a voltage to a load capacitance to finish charging the load capacitance with a predetermined voltage within a predetermined charging period. The voltage supplying device may include:] includes a reference voltage generating circuit having a ladder resistance circuit to which a plurality of resistors are connected in series, which outputs a plurality of voltages divided in the ladder resistance circuit as a plurality of gamma-corrected reference voltages[;] and a plurality of first impedance conversion circuits which perform impedance conversion on the plurality of reference voltages from the reference voltage generating circuit and output the converted voltages[;]. The voltage supplying device also includes a voltage selection circuit having a plurality of analogue switches one of which is turned on based on grayscale data, which selects one of the plurality of reference voltages from the plurality of first impedance conversion circuits[;], a second impedance conversion circuit which performs impedance conversion on a voltage from the voltage selection circuit and outputs the converted voltage[;], a first switching element for blocking an output of the second impedance conversion circuit[;] and a first bypass line for shorting input and output lines of the second impedance conversion circuit[;]. The voltage supplying device further includes a second switching element provided on the

first bypass line[;], a plurality of third switching elements for blocking an output of the plurality of first impedance conversion circuits[;], a plurality of second bypass lines for shorting input and output lines of the respective plurality of first impedance conversion circuits[,] and a plurality of fourth switching elements provided on the respective plurality of second bypass lines.

Furthermore, the first switching element is turned on and the second switching element is turned off in the first period of the charging period, and the first switching element is turned off and the second switching element is turned on in the second period of the charging period which follows after the first period.

Please delete the paragraphs starting on page 6, line 26 through page 12, line 2 as follows:

[According to one aspect of the present invention, the output voltage from the second impedance conversion circuit is supplied to the load capacitance through the first switching element in the first period of the charging period. If an offset is present between the input and output voltages of the second impedance conversion circuit, the load capacitance will not be charged with the predetermined voltage even when the output voltage from the second impedance conversion circuit is continuously supplied to the load capacitance.

Thus, the route for voltage supplying is switched to the first bypass route in the second period of the charging time, whereby the voltage from the voltage selection circuit is directly supplied to the load capacitance without using the second impedance conversion circuit. Accordingly, the load capacitance is supplied with a voltage compensating the shortage caused by the offset and can be charged with the predetermined voltage. The charge amount per unit period of time supplied from the voltage selection circuit to the load capacitance is decreased since the impedance conversion is not

performed. However, if the load capacitance has been charged with a sufficient voltage by the output voltage from the second impedance conversion circuit, the load capacitance can be charged to the predetermined voltage within the charging period.

According one aspect of the present invention, the plurality of third switching elements are turned on and the plurality of fourth switching elements are turned off in the first period of the charging period. As a result, a plurality of reference voltages from the reference voltage generating circuit are current-amplified in the plurality of first impedance conversion circuits. Accordingly, the total resistant value of the ladder resistance circuit of the reference voltage generating circuit is increased and current flowing therethrough is reduced so as to reduce power consumption. At the same time, sufficient current can be supplied to analogue switches having load capacitance.

According to one aspect of the present invention, the plurality of third switching elements are turned off and the plurality of fourth switching elements are turned off at least in a final stage of the second period in order to form a second bypass route. Further, the plurality of third switching elements are turned on and the plurality of fourth switching elements are turned off in the other periods of the charging period. Since input/output offset is caused also in the plurality of first impedance conversion circuits, the offset can be cancelled at least in the last stage of the second period. Here, a node connected to ladder resistors and a node of output voltages are shorted. Therefore, even when the output voltages are set into non-reference voltages, the output voltages are charged/discharged in the ladder resistors and can be reset into proper reference voltages.

According to one aspect of the present invention, because a capacitance for offset canceling used in the conventional technique is not necessary, a period of time for charging the capacitance for offset canceling with an offset voltage is not necessary.

According to one aspect of the present invention, there may be a period in which both the first and second switching elements are turned off. This makes it possible to prevent positive feed back of the voltage from the voltage supplying source through the first bypass line to the impedance conversion circuit.

According to one aspect of the present invention, the voltage supplying device may further comprise a fifth switching element connected to a power supply line which supplies a power source voltage to the plurality of first impedance conversion circuit. The fifth switching circuit is turned off in synchronization with the off operation of the third switching element.

The voltage supplying device may further comprise a sixth switching element connected on a power source line which supplies a power source voltage to the second impedance conversion circuit. The sixth switching element is turned off, synchronized with an off operation of the first switching element. This makes it possible to stop the power supply when the output from the first and second impedance conversion circuits is unnecessary, so as to reduce power consumption.

The second conversion circuit used in one aspect of the present invention may be formed of a voltage follower circuit. When an input voltage having a magnitude near a power source potential VDD or a ground potential VEE is input to the voltage follower circuit, such voltage follower circuit has a property in which an output voltage is saturated and shows no linear characteristics in response to an input voltage. In this case, a voltage from the voltage supplying source is supplied to the load capacitance through the bypass line by turning off the first switching element and turning on the second switching element in a saturated region of an output voltage of the voltage follower circuit. This makes it possible to supply a linear output voltage by directly outputting a voltage from the voltage supplying source in the saturated region in which an output voltage is saturated with respect to a lower or higher input voltage in the voltage follower circuit.

According to one aspect of the present invention, there is provided a semiconductor device comprising the above-described voltage supplying device. In the semiconductor device, a capacitance for offset canceling is unnecessary, so that the chip size can be reduced by the area of the capacitance or other element can be integrated on the area of the capacitance to increase the degree of integration.

According to one aspect of the present invention, there is provided an electro-optical device comprising a display section using an electro-optical element and a semiconductor device which is provided with the above-described voltage supplying device, wherein the semiconductor device is used as a driver IC for driving a signal line of the display section. A precise driving voltage can be supplied to the electro-optical element by supplying a voltage from the voltage supplying source through a signal line of the display section to the electro-optical element.

In this case, the electro-optical element may be driven based on grayscale voltages from the voltage supplying device. The voltage selection circuit can be formed of a digital-analogue converter which converts a digital grayscale signal to an analogue voltage. The first period of the charging period may be finished after the load capacitance is charged with a voltage which has a magnitude within a range corresponding to half of the least signification bit with respect to a desired grayscale voltage value to be supplied to the electro-optical element and which has a magnitude of 90% or more of the desired grayscale voltage value. When a sufficient voltage is supplied to the electro-optical element in the first period of the charging period, the applied voltage to the electro-optical element can reach the desired grayscale voltage even when the voltage from the DA converter is directly supplied to the load capacitance in the second period of the charging period, and furthermore, the gray level in the electro-optical element can be prevented from being differentiated.

According to one aspect of the present invention, there is provided an electronic instrument comprising the above-described electro-optical device. Image quality can be improved by using the electro-optical device as a display of the electronic instrument.

According to one aspect of the present invention, there are provided a plurality of impedance conversion circuits between a reference voltage supplying circuit and a reference voltage generating circuit. The above-described two switching elements and bypass line are connected to the plurality of impedance conversion circuits.]

Please insert the following paragraphs starting at page 14, line 1.

According to one aspect of the present invention, there is provided a voltage supplying device including a reference voltage generating circuit having a ladder resistance circuit to which a plurality of resistors are connected in series, which outputs a plurality of voltages divided in the ladder resistance circuit as a plurality of gamma-corrected reference voltages and a plurality of first impedance conversion circuits which perform impedance conversion on the plurality of reference voltages from the reference voltage generating circuit and output the converted voltages. The voltage supplying device also includes a voltage selection circuit having a plurality of analogue switches one of which is turned on based on grayscale data, which selects one of the plurality of reference voltages from the plurality of first impedance conversion circuits, a second impedance conversion circuit which performs impedance conversion on a voltage from the voltage selection circuit and outputs the converted voltage, a first switching element for blocking an output of the second impedance conversion circuit and a first bypass line for shorting input and output lines of the second impedance conversion circuit. The voltage supplying device further includes a second switching element provided on the first bypass line, a plurality of third switching elements for blocking an output of the plurality of

first impedance conversion circuits, a plurality of second bypass lines for shorting input and output lines of the respective plurality of first impedance conversion circuits and a plurality of fourth switching elements provided on the respective plurality of second bypass lines.

Furthermore, the first switching element is turned on and the second switching element is turned off in the first period of the charging period, and the first switching element is turned off and the second switching element is turned on in the second period of the charging period which follows after the first period.

According to one aspect of the present invention, the output voltage from the second impedance conversion circuit is supplied to the load capacitance through the first switching element in the first period of the charging period. If an offset is present between the input and output voltages of the second impedance conversion circuit, the load capacitance will not be charged with the predetermined voltage even when the output voltage from the second impedance conversion circuit is continuously supplied to the load capacitance.

Thus, the route for voltage supplying is switched to the first bypass route in the second period of the charging time, whereby the voltage from the voltage selection circuit is directly supplied to the load capacitance without using the second impedance conversion circuit. Accordingly, the load capacitance is supplied with a voltage compensating the shortage caused by the offset and can be charged with the predetermined voltage. The charge amount per unit period of time supplied from the voltage selection circuit to the load capacitance is decreased since the impedance conversion is not performed. However, if the load capacitance has been charged with a sufficient voltage by the output voltage from the second impedance conversion circuit, the load capacitance can be charged to the predetermined voltage within the charging period.



According one aspect of the present invention, the plurality of third switching elements are turned on and the plurality of fourth switching elements are turned off in the first period of the charging period. As a result, a plurality of reference voltages from the reference voltage generating circuit are current-amplified in the plurality of first impedance conversion circuits. Accordingly, the total resistant value of the ladder resistance circuit of the reference voltage generating circuit is increased and current flowing therethrough is reduced so as to reduce power consumption. At the same time, sufficient current can be supplied to analogue switches having load capacitance.

According to one aspect of the present invention, the plurality of third switching elements are turned off and the plurality of fourth switching elements are turned off at least in a final stage of the second period in order to form a second bypass route. Further, the plurality of third switching elements are turned on and the plurality of fourth switching elements are turned off in the other periods of the charging period. Since input/output offset is caused also in the plurality of first impedance conversion circuits, the offset can be cancelled at least in the last stage of the second period. Here, a node connected to ladder resistors and a node of output voltages are shorted. Therefore, even when the output voltages are set into non-reference voltages, the output voltages are charged/discharged in the ladder resistors and can be reset into proper reference voltages.

According to one aspect of the present invention, because a capacitance for offset canceling used in the conventional technique is not necessary, a period of time for charging the capacitance for offset canceling with an offset voltage is not necessary.

According to one aspect of the present invention, there may be a period in which both the first and second switching elements are turned off. This makes it possible to prevent positive feed back of the voltage from the voltage

supplying source through the first bypass line to the impedance conversion circuit.

According to one aspect of the present invention, the voltage supplying device may further include a fifth switching element connected to a power supply line which supplies a power source voltage to the plurality of first impedance conversion circuit. The fifth switching circuit is turned off in synchronization with the off operation of the third switching element.

The voltage supplying device may further include a sixth switching element connected on a power source line which supplies a power source voltage to the second impedance conversion circuit. The sixth switching element is turned off, synchronized with an off operation of the first switching element. This makes it possible to stop the power supply when the output from the first and second impedance conversion circuits is unnecessary, so as to reduce power consumption.

The second conversion circuit used in one aspect of the present invention may be formed of a voltage follower circuit. When an input voltage having a magnitude near a power source potential VDD or a ground potential VEE is input to the voltage follower circuit, such voltage follower circuit has a property in which an output voltage is saturated and shows no linear characteristics in response to an input voltage. In this case, a voltage from the voltage supplying source is supplied to the load capacitance through the bypass line by turning off the first switching element and turning on the second switching element in a saturated region of an output voltage of the voltage follower circuit. This makes it possible to supply a linear output voltage by directly outputting a voltage from the voltage supplying source in the saturated region in which an output voltage is saturated with respect to a lower or higher input voltage in the voltage follower circuit.

According to one aspect of the present invention, there is provided a semiconductor device including the above-described voltage supplying device. In the semiconductor device, a capacitance for offset canceling is unnecessary.

so that the chip size can be reduced by the area of the capacitance or other element can be integrated on the area of the capacitance to increase the degree of integration.

According to one aspect of the present invention, there is provided an electro-optical device including a display section using an electro-optical element and a semiconductor device which is provided with the above-described voltage supplying device, wherein the semiconductor device is used as a driver IC for driving a signal line of the display section. A precise driving voltage can be supplied to the electro-optical element by supplying a voltage from the voltage supplying source through a signal line of the display section to the electro-optical element.

In this case, the electro-optical element may be driven based on grayscale voltages from the voltage supplying device. The voltage selection circuit can be formed of a digital-analogue converter which converts a digital grayscale signal to an analogue voltage. The first period of the charging period may be finished after the load capacitance is charged with a voltage which has a magnitude within a range corresponding to half of the least signification bit with respect to a desired grayscale voltage value to be supplied to the electro-optical element and which has a magnitude of 90% or more of the desired grayscale voltage value. When a sufficient voltage is supplied to the electro-optical element in the first period of the charging period, the applied voltage to the electro-optical element can reach the desired grayscale voltage even when the voltage from the DA converter is directly supplied to the load capacitance in the second period of the charging period, and furthermore, the gray level in the electro-optical element can be prevented from being differentiated.

According to one aspect of the present invention, there is provided an electronic instrument including the above-described electro-optical device. Image quality can be improved by using the electro-optical device as a display of the electronic instrument.

According to one aspect of the present invention, there are provided a plurality of impedance conversion circuits between a reference voltage supplying circuit and a reference voltage generating circuit. The above-described two switching elements and bypass line are connected to the plurality of impedance conversion circuits.

IN THE ABSTRACT:

Please amend the original Abstract of the Disclosure as indicated below.

A voltage supplying device includes [comprises a reference voltage generating circuit, a first impedance conversion circuit for performing the impedance conversion on a reference voltage, a digital-analogue converter (DAC) and a second impedance conversion circuit for performing the impedance conversion on a voltage from the DAC. A first switching element is provided between the output of the second impedance conversion circuit and the load capacitance. A first bypass line is provided for bypassing the second impedance conversion circuit and the first switching element, and a second switching element is provided on the bypass line. In the first period of the charging period, the output of the second impedance conversion circuit is supplied to the load capacitance. In the second period of the charging period, the output of the DAC is supplied to the load capacitance. Third and fourth switching elements and a second bypass line are provided in the first impedance conversion circuit and the second bypass line is used at least in the last stage of the second period] a reference voltage generating circuit having a ladder resistance circuit to which a plurality of resistors are connected in series, which outputs a plurality of voltages divided in the ladder resistance circuit as a plurality of gamma-corrected reference voltages and a plurality of first impedance conversion circuits which perform impedance conversion on the plurality of reference voltages from the reference voltage generating circuit and output the converted voltages. The

voltage supplying device also includes a voltage selection circuit having a plurality of analogue switches one of which is turned on based on grayscale data, which selects one of the plurality of reference voltages from the plurality of first impedance conversion circuits, a second impedance conversion circuit which performs impedance conversion on a voltage from the voltage selection circuit and outputs the converted voltage, a first switching element for blocking an output of the second impedance conversion circuit and a first bypass line for shorting input and output lines of the second impedance conversion circuit. The voltage supplying device further includes a second switching element provided on the first bypass line, a plurality of third switching elements for blocking an output of the plurality of first impedance conversion circuits, a plurality of second bypass lines for shorting input and output lines of the respective plurality of first impedance conversion circuits and a plurality of fourth switching elements provided on the respective plurality of second bypass lines.

Furthermore, the first switching element is turned on and the second switching element is turned off in the first period of the charging period, and the first switching element is turned off and the second switching element is turned on in the second period of the charging period which follows after the first period.

#### IN THE CLAIMS:

Please amend claim 1 as indicated below:

1. (Once Amended) A voltage supplying device [which supplies a voltage to a load capacitance to finish charging the load capacitance with a predetermined voltage within a predetermined charging period, the voltage supplying device] comprising:

a reference voltage generating circuit having a ladder resistance circuit to which a plurality of resistors are connected in series, which outputs a

plurality of voltages divided in the ladder resistance circuit as a plurality of gamma-corrected reference voltages;

a plurality of first impedance conversion circuits which [perform] performs impedance conversion on the plurality of reference voltages from the reference voltage generating circuit and [output] outputs the converted voltages;

a voltage selection circuit having a plurality of analogue switches one of which is turned on based on grayscale data, which selects one of the plurality of reference voltages from the plurality of first impedance conversion circuits;

a second impedance conversion circuit which performs impedance conversion on a voltage from the voltage selection circuit and outputs the converted voltage;

a first switching element for blocking an output of the second impedance conversion circuit;

a first bypass line for shorting input and output lines of the second impedance conversion circuit;

a second switching element provided on the first bypass line;

a plurality of third switching elements for blocking an output of the plurality of first impedance conversion circuits;

a plurality of second bypass lines for shorting input and output lines of the respective plurality of first impedance conversion circuits; and

a plurality of fourth switching elements provided on the respective plurality of second bypass lines,

wherein the first switching element is turned on and the second switching element is turned off in [the] a first period of [the] a charging period, and the first switching element is turned off and the second switching element is turned on in [the] a second period of the charging period which follows after the first period; and

wherein the plurality of third switching elements are turned off and the plurality of fourth switching elements are turned on at least in a final stage of the second period, and the plurality of third switching elements are turned on and the plurality of fourth switching elements are turned off in the other periods of the charging period.